A Demonstration of FaceDisplay: Asymetric Multi-User Interaction for Mobile VR

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Figure 1: FaceDisplay is a modified VR HMD consisting of three touch sensitive displays and a depth camera attached to its back (a-c). This allows people in the surrounding to perceive the virtual world through the displays and interact with the HMD user either through touch (e) or gestures (d).

Abstract

Mobile VR HMDs enable users to experience virtual reality content in a variety of nomadic scenarios, excluding all the people in the surrounding (*Non-HMD Users*) and reducing them to be sole bystanders. This leads to a scenario where the *HMD User* experiences a sense of *isolation* and the *Non-HMD Users* a sense of *exclusion*. To battle these phenomena we present *FaceDisplay*, a modified VR HMD consisting of three touch sensitive displays and a depth camera attached to its back. This allows *Non-HMD User* to see inside the immersed users virtual world and enable them to interact via touch and gestures. We built a VR HMD prototype consisting of three additional screens and present interaction techniques and an example application that leverage the *FaceDisplay* design space.

Index Terms: Human-centered computing—Visualization—Visualization techniques—Treemaps; Human-centered computing—Visualization—Visualization design and evaluation methods

1 Introduction

Mobile VR describes a type of VR HMDs which have display, optics and processing embedded into one device, allowing users to access VR wherever and whenever they want. This leads to a new interaction scenario (Nomadic VR), where a user interacts with a mobile VR HMD in an instrumented and sometimes public environment [2]. The nomadic scenario creates two big challenges: *exclusion* (the *Non-HMD User* being excluded from the VR experience becoming a soley bystander and onlooker) and *isolation* (the *HMD User* being alone inside the environment not being able to experience it with co-located friends). In stationary scenarios this is often solved using external screens which mirror the immersed user's view or with concepts that introduce additional hardware for the non-HMD user to view and interact inside the virtual world [4]. We present *FaceDisplay*, a mobile VR HMD allowing non-HMD user to see and interact with the virtual world of the immersed user (figure 1).

Prior work on mobile VR already started to extend the capabilities of feedback and interaction inside the nomadic VR scenario by embedding new technology into the HMD itself [3, 5, 7, 8]. This approach allows to keep the amount of additional accessories low and supports the nomadic scenario. Pohl et al. presented in [7] a similar approach to *FaceDisplay*, by attaching one screen to the back of a Google Cardboard that mirrored the immersed users view. The goal of the project was to increase social acceptance of mobile VR HMDs by showing people in the surrounding what the user with the HMD actually does. In *FaceDisplay*, our goal was not only to let the bystander see the virtual environment but also enable them to interact with the HMD user without additional accessories. Most recently Chan et al. presented with "FrontFace" a single screen attached to the back of a mobile VR HMD to lower the communication barrier between *HMD User* and *Non-HMD User* [1]. The technical setup is similar to *FaceDisplay* but the focus lies on enabling a form of communication rather than letting the *Non-HMD User* be part of the experience (lower exclusion) or allow the *Non-HMD User* to interact with the virtual world. Another similar hardware setup consisting of a tablet attached to the back of a mobile VR HMD was presented by Misawa et al. [6]. The intention however was to build a remote telepresence system using a human-surrogate and not on enhancing any form of interaction for mobile VR. To the best of our knowledge, *FaceDisplay* is the first approach which presents asymmetric multi-user interaction for mobile VR.

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2 FaceDisplay System

The core idea bhind *FaceDisplay* is to explore the notion of a more social mobile VR HMDs. Hereby, we try to push on the notion of mobile VR HMDs which are not solely designed for the user who

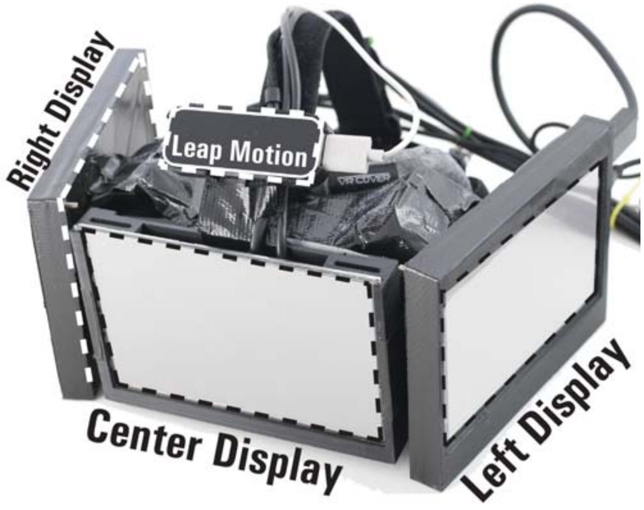

Figure 2: The hardware prototype of FaceDisplay, consisting of three touchscreens and a Leap Motion depth camera attached to the back and the sides of an Oculus Rift DK2

wears it but also includes visualization and interaction concepts for people in the surrounding.

Our current prototype consists of an Oculus Rift DK2 and three displays attached to the back and sides of the HMD (figure 2). We used two 7 inch Waveshare screens for the sides (resolution: 1024x600) and a 7 inch ChalkBoard Electronics display on the back (resolution: 1280x800). The two screens on the side are attached with an angle of 75 degree to be still partially visible when looking straight onto the HMD. Each display is capable of capacitive multi-touch. Additionally, we attached a Leap Motion controller that was tilted by approximately 45 degrees, facing slightly upwards (Fig. 2). This allowed us to mainly see the hands of the *Non-HMD User* and a further away background (e.g. ceiling). This was necessary to increase the tracking accuracy since the Leap Motion has to conduct figure-ground separation of the depth image and fails if something (e.g. human torso) is at approximately equal distance as the hands.

These two forms of input (touch and rotate) are the basic forms of interaction *FaceDisplay* is designed around. We are currently running a study to explore the social implications of these interaction forms and trying to assess their impact on immersion, enjoyment and mainly comfort.

3 Demo Applications

FruitSlicer is a VR adaption of the popular Fruit Ninja game. The *HMD User* is located inside a virtual environment and different sorts of fruits and vegetables are thrown towards him. To collect points the *HMD User* has to slice all the fruits and vegetables and avoid slicing the bombs. The *Non-HMD User* can decide at which frequency and what location the next object is going to spawn and "throw" them towards the *HMD User*. When the *HMD User* misses a fruit or slices a bomb, he loses one point and for every rightfully sliced fruit or vegetable, he gains a point. The first to get 10 points wins.

The *HMD User* sees the world from a first person perspective and can generate slices inside the virtual world by touching and moving his finger on the corresponding location on the center display (Fig. 3 a). This form of interaction was shown to be suitable for mobile VR HMDs [3]. The *Non-HMD User* is looking from a far distance into the virtual world and can see a visualization of the *HMD User* and the spawning objects and slices (Fig. 3 c). By touching one of the screens the *Non-HMD User* spawns a random object (fruit/vegetable/bomb) and throws it towards the *HMD User*.

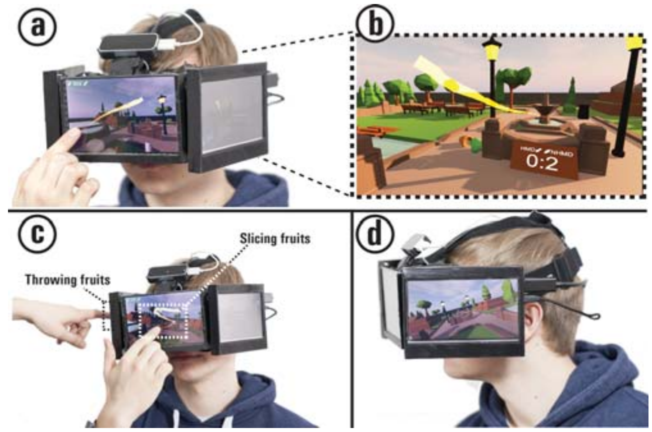

Figure 3: The FruitSlicer application with its outside view (a), inside view (b), interaction concepts (c) and visualization metaphor (d).

4 Conclusion

This research demo presented *FaceDisplay*, a multi-display VR HMD enabling asymmetric interaction for mobile virtual reality. We focused on a system design that aims to remove *isoation* and *exclusion* in nomadic scenarios. We presented our technical prototype and presented an example application focused on enabling a non-HMD user to interact with the virtual world without having to wear an HMD himself.We want to emphasize, that the goal of *FaceDisplay* is not to create an equivalent VR experience for the non-HMD user but to allow for a whole new form of experiencing VR and interacting with a VR HMD user without having to wear an own HMD. Our main messag is that future VR HMDs should not only focus on the *HMD User* but also have to think aboue the enviornment of the usage and enable the sharing and interacting with *Non-HMD Users*.

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